KUS-W80 Underwater Distance Sensor
Operation Manual

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1.Introduction

The single-beam underwater ultrasonic ranging sensor is a high-response ranging sensor designed based on the ARM architecture.
The sensor has a built-in RS485 chip to read data and configure internal parameters. The internal parameters can be modified through the ModBus-RTU protocol to adjust the performance of the sensor and implement certain functions.

2.Measurement principle

During the distance measurement process, the ultrasonic signal is emitted by the ultrasonic probe, reflected by the liquid or other solid medium, and then reflected by the same probe. The time difference between the ultrasonic emission and reception is measured to achieve the level measurement. The relationship between the sound wave transmission distance L, the sound velocity v and the sound wave transmission time t can be expressed by the formula:

Ultrasonic distance measurement formula $L = \frac{1}{2}vt$

L: The distance between the ultrasonic probe and the measured material surface. Unit: m;
v: The sound velocity value after temperature compensation. Unit: m/s;
t: The running time of the sound wave within the measurement range. Unit: s

3.Features

- Protection level: IP68
- Equipped with RS485 communication, data can be read and written
- Address, baud rate, and other corresponding parameters can be modified through ModBus-RTU protocol;
- Short response time
- Temperature compensation

4.Application

- Underwater position and distance detection
- Underwater robot obstacle avoidance and collision detection
- Underwater gate switch status monitoring
- Tank water level monitoring
- Unmanned boat application

5.Technical Parameters

General parameters	
Blind area	0. 6m
Detection range	0. 6m~100m
Transducer frequency	200kHz
Electrical characteristics	
Working voltage	10.8V~26.4VDC, reverse polarity protection
No-load current	≤15mA
Voltage drop	≤ 2.5V
Start-up delay	<2000ms (software delay for protection)
Output characteristics	
Output type	Standard RS485 output (Modbus-RTU protocol)
Rated working current Ie	≤100mA, short circuit/overload protection
Repeatability accuracy	±0.25%
Accuracy	±0.5%
Ambient temperature	
Working temperature	-20~60℃
Storage temperature	-20~60℃
Mechanical characteristics	
Output connection method	4-core outlet
Output line length	Default 2 meters (other line lengths need to be customized)
Protection level	IP68
Material	Casing: ABS, PC

6.Wiring

Red--------Power + White (blue wire)----485A

Black------Power - Yellow (yellow-green wire)-----485B

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Output settings

The sensor has a built-in 485 chip, which can set the NPN switch output and read the corresponding measurement value. The Modbus-RTU standard protocol is used.

Communication example:

01 03 00 00 00 01 84 0A reads the first distance value;

01 03 00 01 00 01 D5 CA reads the second distance value; (set to the level height value)

01 03 00 02 00 01 25 CA reads the sensor temperature value.

Comprehensive command: 01 03 00 00 00 03 05 CB

Reply: 01 03 06 03 20 04 B0 08 34 A6 41A

03 20 1st distance value: 800mm // Large range distance value: 800cm

04 B0 2nd distance value: 1200mm

34 A6 Temperature value: 21℃

7.MODBUS Communication Protocol

7.1 Serial Port Parameters

(1) The hardware adopts RS-485, master-slave half-duplex communication, the master calls the slave address, and the slave responds to the communication

(2) Data frame 10 bits, 1 start bit, 8 data bits, 1 stop bit, no check;

(3) Baud rate: 4800 9600 19200 38400 115200 (default is 115200).

7.2 Read Single Register

Function code: 03H

Host sends							
1	2	3	4	5	6	7	8
ADDR	03H	Start register high byte	Start register low byte	Register number high byte	Register number low byte	CRC code low byte	CRC code high byte

Byte 1 ADDR: slave address code (0x01~0xFE);

Byte 2 03H: function code;

Bytes 3 and 4: register address to be read;

Bytes 5 and 6: number of registers to be read, 0x0001 for reading a single register;

Bytes 7 and 8: CRC16 checksum from byte 1 to byte 6.

Slave receives						
1	2	3	4	5	6	7
ADDR	03H	Total bytes	Data high byte	Data low byte	CRC code low byte	CRC code high byte

Byte 1 ADDR: slave address code (0x01~0xFE);

Byte 2 03H: function code;

Byte 3: The total number of data bytes received. If a single register is read, the total number of bytes is 02;

Bytes 4 and 5: register data, each data occupies 2 bytes;

Bytes 6 and 7: CRC16 check code from byte 1 to byte 5.

7.3 Read multiple registers

Function code: 03H

Host sends							
1	2	3	4	5	6	7	8
ADDR	03H	Start register high byte	Start register low byte	Register number high byte	Register number low byte	CRC code low byte	CRC code high byte

Refer to the method of **reading a single register**. When reading distance and temperature at the same time, the number of registers is 0x0002;

Slave receives									
1	2	3	4、5		…	N−1、N		N+1	N+2
ADDR	03H	Total bytes	Data1 high byte	Data1 low byte	…	Data N high byte	Data N low byte	CRC code low byte	CRC code high byte

Refer to the method of **reading a single register**. Data 1 is the starting register value to be read. Each data occupies 2 bytes. The number of data returned depends on the number of registers read by the user.

7.4 Write Single Register

Function code: 06H

Host sends							
1	2	3	4	5	6	7	8
ADDR	06H	Register address high byte	Register address low byte	Data high byte	Data low byte	CRC code low byte	CRC code high byte

Byte 1 ADDR: slave address code (0x01~0xFE);
Byte 2 06H: function code;
Bytes 3 and 4: the written register address;
Bytes 5 and 6: register data corresponding to the register address;
Bytes 7 and 8: CRC16 check code from byte 1 to byte 6.

Slave receives							
1	2	3	4	5	6	7	8
ADDR	06H	Register high byte	Register low byte	Data high byte	Data low byte	CRC code low byte	CRC code high byte

Byte 1 ADDR: slave address code (0x01~0xFE);
Byte 2 06H: function code;
Bytes 3 and 4: the register address written;
Bytes 5 and 6: the register data corresponding to the register address;
Bytes 7 and 8: the CRC16 checksum from byte 1 to byte 6.

7.5 Error Code

1	2	3	4	5
ADDR	Function code	Error code	CRC code low byte	CRC code high byte

Byte 1 ADDR: slave address code (0x01 ~ 0xFE);
Byte 2 83H or 86H: function code (83H means an error is reported for the read command, 86H means an error is reported for the write command);
Byte 3: Reference **error message code table**;
Bytes 4 and 5: CRC16 check code from byte 1 to byte 3.

Error message code table	
Information Code	**Remarks**
01H	Illegal function code
02H	Illegal data address
03H	Illegal data value
04H	CRC16 check error
05H	Received correctly
06H	Received incorrectly
07H	Parameter error

7.6 Register Definition Table

Register Definition Table									
Register address	Description			Read only	Register address	Description			Read only
0000	0	1	Distance	√	0001	2	3	Reserved	√
0002	4	5	Temperature	√	0003	6	7	Reserved	√
0032	100	101			0033	102	103		
0034	104	105			0035	106	107		
005C	184	185	(185)RX-MOD //Active upload mode is 2		005D	186	187		
005E	188	189			005F	190	191		
0060	192	193			0061	194	195	Factory reset System reset	
0062	196	197	Baud rate setting METERWORK		0063	198	199	Pulse quantity	
0068	208	209			0069	210	211		
006A	212	213			006B	214	215	Meter type √ Instrument address	
006C	216	217			006D				

7.7 Routines

Single-beam underwater ultrasonic distance sensor			
Commands	**Send**	**Receive**	**Notes**
Read command	01 03 00 00 00 01 84 0A	01 03 02 07 D0 BB E8	Distance value: 2000mm//Large range 2000cm
	01 03 00 02 00 01 25 CA	01 03 02 0B 31 7E A0	Temperature value: 28.65℃
	01 03 00 00 00 02 C4 0B	01 03 04 07 D0 0B 31 3C 5A	Read two register data at the same time
Write command	01 06 00 5C 00 02 C8 19	01 06 00 5C 00 02 C8 19	Change to active upload mode
	01 06 00 5C 00 00 49 D8	01 06 00 5C 00 00 49 D8	Change to passive upload mode
	01 06 00 6B 00 02 79 D7	**01 06 00 6B 00 02 79 D7**	Known that the current instrument address is 01, change to 02
	01 06 00 62 01 00 29 84	01 06 00 62 01 00 29 84	Change the baud rate to 9600
	01 06 00 61 01 00 D9 84	01 06 00 61 01 00 D9 84	System restores factory settings
	01 06 00 61 00 01 19 D4	01 06 00 61 00 01 19 D4	System reset
	01 06 00 5C 00 02 C8 19	01 06 00 5C 00 02 C8 19	Change to active upload mode
Error command	01 03 00 0C 00 01 44 09	01 83 02 C0 F1	02 indicates error message code: illegal data address

7.8 Protocol Description

7.8.1 Temperature value (REG_ADDR: 0001H)

The temperature value is represented by 2-byte unsigned data. The read value divided by 100 is the temperature value, unit: °C. The highest bit of the high byte is the sign bit, 0 for positive, 1 for negative.

7.8.2 Query/set error compensation (REG_ADDR: 0004H)

The error compensation value is represented by 2-byte unsigned data, unit: mm. When the distance measurement error exceeds the maximum allowable range, this value can be used for slight compensation. The default compensation value is 0. The compensation value is to split the int16_t type data into two bytes, with the high byte in front and the low byte in the back. The format is the storage format of the value in the computer.

Negative compensation value = 65535-error value.
For example: if the error value is 35mm, the compensation value is 65500, which is converted to hexadecimal: 0xFFDC

The modification command is 01 06 00 04 FF DC 88 62
The positive compensation value can be a hexadecimal number.
For example: if the error value is 25mm, it is converted to hexadecimal: 0x0019
The modification command is 01 06 00 04 00 19 09 C1